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DELINTING AND RECLEANING COTTONSEED FOR PLANTING PURPOSES.

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The practice of delinting and recleaning cottonseed for planting purposes is coming into more general use. Increasing interest is being manifested by large cottonseed growers and dealers in the commercial possibilities and agricultural advantages of one or both of these operations. Investigations show that each of the two processes possesses certain definite advantages but is of greatest value or is most effective when performed in conjunction with the other. That is, cottonseed which has been delinted is still further improved for planting purposes by subsequent recleaning, and recleaning is much more effective if the seeds previously have been delinted.

These investigations include a series of tests and experiments conducted for the purpose of determining the effect of delinting at varying rates of cut on the percentage of the seeds injured by the delinter saws, the appearance of the seeds, germination, planting capacity, and weight per bushel or volume of 30 pounds in terms of a bushel. The delinted seeds used in making the tests were taken from an average lot of the Express variety grown from selected seed in Mississippi County, Ark., in 1921. Similar tests with delinted seed of the Cleveland variety, as far as they have been made, bear out the conclusions drawn from those made with the Express, but because of the incompleteness of the data the detailed results are omitted from this discussion.

Note.—Credit is due the large number of cottonseed dealers and growers, experiment-station representatives, and machinery manufacturers who have cooperated freely with the writer in obtaining the data presented in this bulletin.

Analyses also were made of a number of samples of recleaned seed together with corresponding ginned, delinted, and dockage samples of the Express, Cleveland, Half and Half, Acala, Lone Star, Triumph, Rowden, Kasch, and Over-the-Top varieties, so far as available to ascertain the degree of success with which cottonseed is now being recleaned by various dealers and the factors affecting the efficient operation of recleaning machines. Special attention was given to delinting as such a factor. In addition, studies were made relative to the cost of the combined operations, delinting and recleaning, and their effect on the commercial and agricultural value of cotton seed for planting purposes.

Detailed results of these tests and experiments, and conclusions drawn from them, are given in this bulletin for the purpose of intensifying the interest now manifested in the improvement of cottonseed for planting purposes by delinting and recleaning and of showing the interdependence of the two processes in producing the highest grade product.

THE RATE OF DELINTING.

The rate of delinting or the quantity of linters removed per ton of seed is the basis for measuring the effectiveness of the delinting operation. For use in making tests to determine the effects of delinting at varying rates, a series of samples (about 1 pound each) of cottonseed were obtained from a commercial ginning, delinting, and recleaning plant.[1]

In collecting the samples, the machinery was operated and adjustments were made under the direct supervision of the writer. First, the seed roll in the delinting machine was adjusted to run very loosely, cutting a very small quantity of linters from the seed. Five samples were collected from the seed thus delinted and one sample from the corresponding lot of ginned seed. The roll was then tightened slightly and the machine allowed to run about 10 minutes. From this lot of delinted seed, five samples were collected, together with one ginned sample as before. This procedure was continued until eight sets of samples, consisting of five delinted and one ginned, were collected, each succeeding set being delinted more closely than the preceding one. By this time the roll was very compact. Practically all of the lint or fuzz was removed from the seeds in the eighth set of delinted samples and apparently a larger percentage of them was cut or broken by the delinter saws.

The comparative rate at which these samples were delinted was ascertained by comparing the weight of 100 delinted seeds in each set with that of 100 ginned seeds in the same set. The weights used in each case represent the average of five separate weights of 100 seeds each, taken indiscriminately from the respective samples. From these average weights the percentage of reduction in weight of the seed by delinting was computed. This percentage figure multiplied by 2,000 gives the equivalent pounds of linters cut per ton of seed as shown in Table 1.

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[1] The delinting machine was the same type as that used extensively in cottonseed oil mills, and the recleaning machine a type used for recleaning all kinds of seeds—grains, peas, beans, grasses, and clovers.

TABLE 1.—*Rate of delinting or linters cut per ton of seed.*

Sample No.	Reduction in weight of 100 seeds by delinting.		Equivalent to linters cut per ton of seed.[1]	Sample No.	Reduction in weight of 100 seeds by delinting.		Equivalent to linters cut per ton of seed.[1]
	Milligrams.	*Per cent.*	*Pounds.*		*Milligrams.*	*Per cent.*	*Pounds.*
21	212	1.89	37.8	25	670	6.00	120.0
22	360	3.22	64.4	26	786	6.97	139.4
23	448	4.01	80.2	27	898	8.05	161.0
24	534	4.76	95.2	28	1,002	8.97	179.4

[1] Includes invisible loss through automatic removal of inert matter.

SEEDS CUT BY DELINTER SAWS.

In delinting, or even in ginning, a small percentage of the seed may be cut or broken by the saws. For the purpose of determining more definitely the extent of such injury, five 100-seed samples of each set of delinted seed were examined and the number of injured seeds counted. The average percentage of the seeds injured in each set or at each rate of cut is shown in Table 2 and is graphically illustrated in Figure 1.

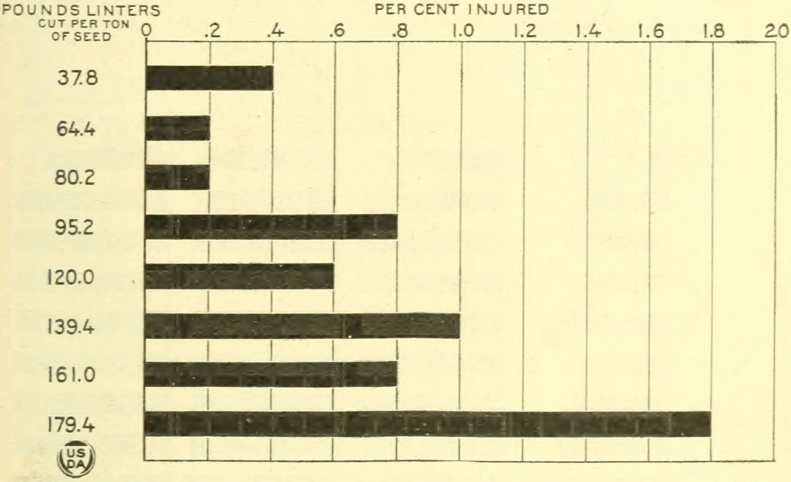

FIG. 1.—The percentage of cottonseeds injured by delinter saws is very small. Less than 1 per cent was injured when 161 pounds of linters per ton of seed were removed.

TABLE 2.—*Percentage of seeds injured by delinter saws at varying rates of delinting.*

Rate of delinting (linters per ton of seed).	Seeds cut by delinter saws.	Rate of delinting (linters per ton of seed).	Seeds cut by delinter saws.
Pounds.	*Per cent.*	*Pounds.*	*Per cent.*
37.8	0.4	120.0	0.6
64.4	0.2	139.4	1.0
80.2	0.2	161.0	0.8
95.2	0.8	179.4	1.8

Table 2 shows that seed may be delinted very closely with not over 1 per cent of saw-cut injury. One lot was delinted at a rate of 161 pounds of linters per ton and only 0.8 per cent showed injury. This seems to be the maximum rate at which the seed may be delinted with safety. Most of the lint or fuzz is removed and little advantage is gained by attempting to delint more closely.

Saw-cut injury to the seed is affected by the condition of the machinery. The saws should be kept moderately sharp. Filing them at regular intervals of 24 to 36 hours run insures uniform delinting as well as reduces the liability of breaking the seed. In a two-unit delinting plant which has come under the writer's observation an extra saw cylinder was provided. With the aid of an automatic gummer and filer, the saws were gummed and filed by the operator in charge of the delinters. With this arrangement, a sharp set of saws was available for replacing any dull cylinder without loss of time and with no extra expense incurred for labor.

APPEARANCE OF DELINTED SEED.

A larger percentage of the black hull or seed coat is exposed as the rate of delinting increases. At the maximum rate at which seed may be delinted with safety, very little linters or fuzz is left on them. The contrast between the appearance of ginned cottonseed and seed delinted at varying rates is illustrated in Plate I.

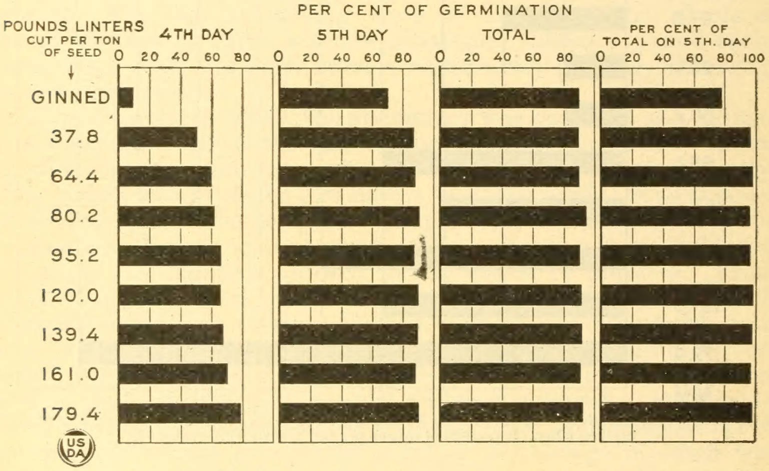

FIG. 2.—Delinted cottonseeds germinate more quickly than ginned seeds. In greenhouse tests ginned seeds showed only 9 per cent germination in 4 days, compared with 70 per cent for seed delinted at a rate of 161 pounds per ton. The final percentage of seeds germinating was not affected by delinting.

EFFECT OF DELINTING ON GERMINATION.[2]

Delinting reduces the time required for cottonseed to germinate. It promotes uniform germination and a maximum stand of plants in the shortest possible time. A larger percentage of the viable seed germinates in a given limited period. This percentage tends to vary directly with the rate of cut.

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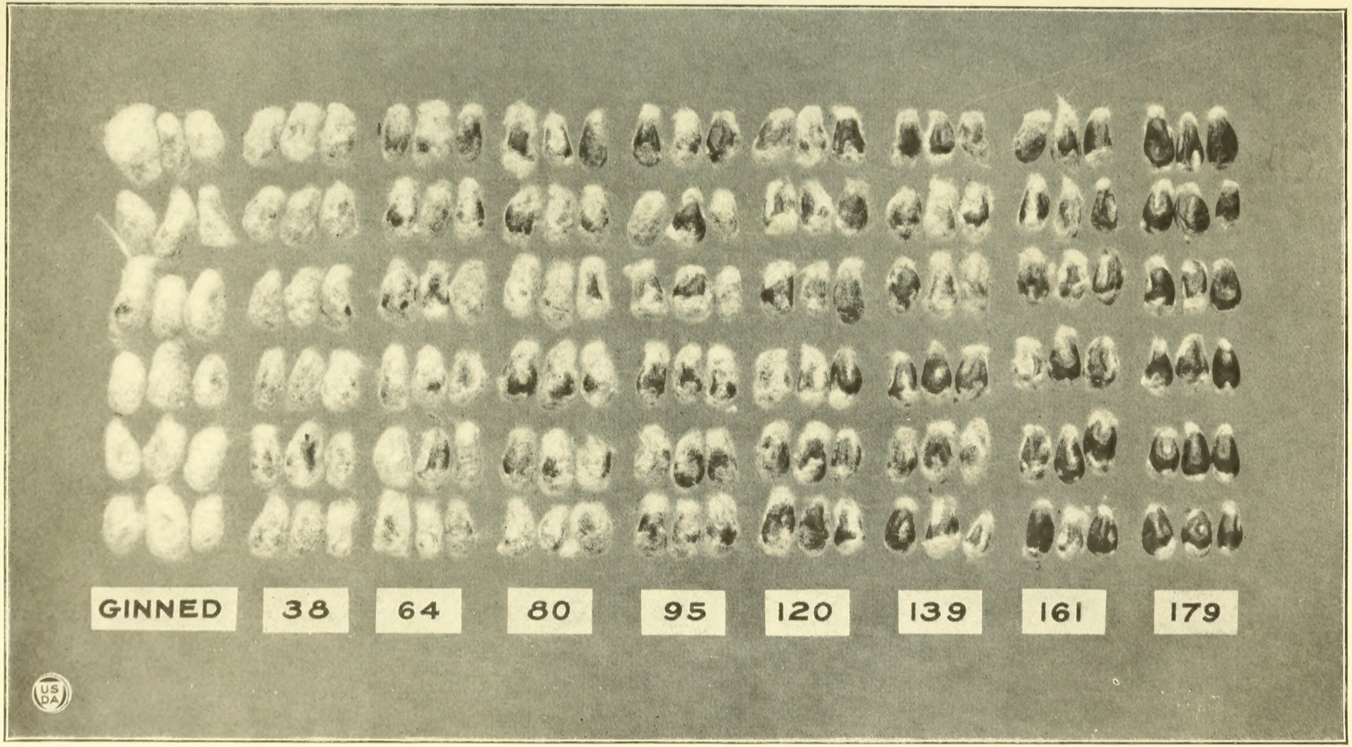
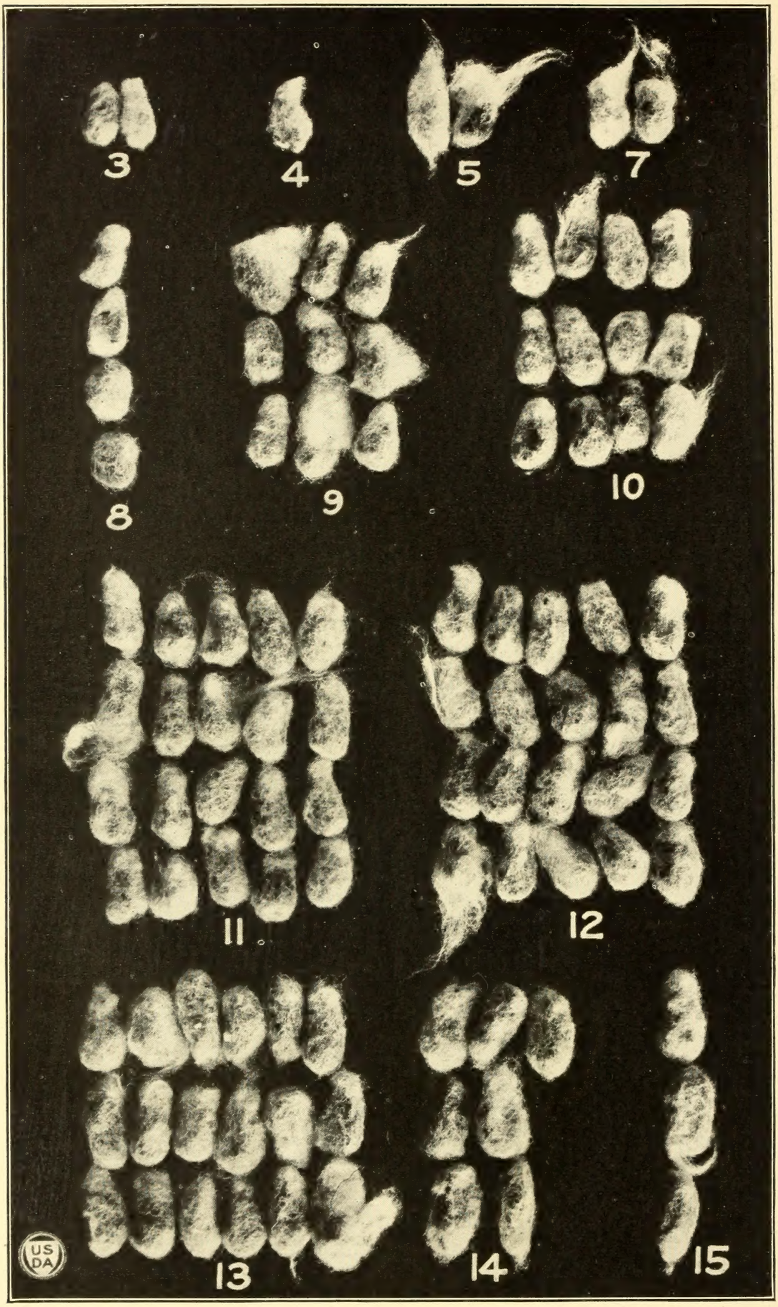
[2] All germination tests referred to in this discussion were made by and under the direction of W. L. Goss, of the Seed Laboratory of the Bureau of Plant Industry.



COTTONSEED AS IT COMES FROM THE GIN AND AS IT APPEARS WHEN DELINTED AT VARYING RATES.

Figures indicate pounds of linters removed per ton of seed. About three-fourths natural size.



GINNED COTTONSEED. FIGURES INDICATE THE WEIGHTS IN CENTIGRAMS OF THE INDIVIDUAL SEEDS IN EACH GROUP.

Note that seven weigh less than 8 centigrams each. Slightly reduced in size.

Germination tests of each set of samples were made in the Seed Laboratory with the results shown in Table 3. Each germination percentage is the average of three tests made in duplicate.

TABLE 3.—*Germination of cottonseed delinted at varying rates (laboratory tests).*

Rate of delinting (linters per ton).	Germination.		Percentage of total seeds germinating that germinated in 4 days.	Rate of delinting (linters per ton).	Germination.		Percentage of total seeds germinating that germinated in 4 days.
	Fourth day.	Ninth day (final).			Fourth day.	Ninth day (final).	
Pounds.	*Per cent.*	*Per cent.*	*Per cent.*	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*
Ginned.	52.0	83.0	62.6	120.0	65.3	85.8	76.1
37.8	61.5	84.0	73.2	139.4	66.5	77.5	85.8
64.4	63.5	86.2	73.7	161.0	66.8	75.3	88.7
[1] 80.2	....	....	....	179.4	71.2	84.0	84.8
95.2	60.0	84.0	71.4				

[1] Results omitted because of element of error in test.

Further proof of the shorter duration required for the germination of delinted seed is shown by the results of soil tests conducted in the greenhouse. These tests were made in triplicate; that is, three 100-seed tests were made of the ginned seed and of seeds delinted at each rate of cut. Counts were made daily beginning with the fourth day, counting all seedlings of which the cotyledons had opened and averaging the results of the three tests in each lot. Detailed results of these tests are given in Table 4 and presented graphically in Figure 2.

TABLE 4.—*Germination of cottonseed delinted at varying rates (greenhouse tests).*

Rate of delinting (linters per ton).	Germination as shown by daily counts.				Percentage of total number germinating that germinated in a given time.		
	Fourth day.	Fifth day.	Sixth day.	Final.	4 days.	5 days.	6 days.
Pounds.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Ginned.	9.0	70.3	85.7	90.0	10.0	78.1	95.2
37.8	51.0	87.0	89.3	89.7	56.8	97.0	99.6
64.4	60.0	88.0	89.7	89.7	66.9	98.1	100.0
80.2	62.0	91.3	94.3	94.7	65.5	96.4	99.6
95.2	66.0	87.3	90.0	90.3	73.1	96.7	99.7
120.0	65.7	90.3	91.3	91.7	71.6	98.5	99.6
139.4	67.3	90.0	91.7	92.0	73.2	97.8	99.7
161.0	70.0	88.3	91.0	91.0	76.9	97.0	100.0
179.4	78.7	90.7	92.7	92.7	84.9	97.8	100.0

In all greenhouse tests the final or total percentage of germination of each delinted sample was practically equal to and in most instances higher than that of the ginned sample. This indicates that the delinting operation does not injure the germination. Also the greenhouse tests were conducted during August, 1922, while the seeds used were delinted on October 14, 1921, and were stored in bags during the intervening period of 10 months. This seems to disprove the theory sometimes advanced that delinted seeds would lose their viability quickly and would be of little value for planting purposes if stored for any length of time.

Moisture and temperature conditions in the greenhouse were comparable to what would be termed ideal field conditions. The experience of large farmers over a period of years covering extensive plantings show conclusively that under average field conditions the variation between the time required for the germination of ginned and closely delinted cottonseed is greater than that shown in the table and chart referred to. Under unfavorable field conditions, especially where a deficiency of moisture is a factor, the results in favor of delinted seed are much more pronounced.

EFFECT OF DELINTING ON THE PLANTING CAPACITY.

Delinting increases the planting capacity of cottonseed per unit. It reduces the weights of the individual seeds, hence increases the number of seeds per unit of weight. The planting capacity per unit of weight is increased in the same proportion as the number of seeds and the percentage of increase in planting capacity is slightly greater than the percentage of reduction in the weights of the individual seeds. The reduction in the average weight of the individual seeds and the extent to which the number of seeds per unit of weight, and consequent planting capacity, is increased at varying rates of delinting, are shown in Table 5 and are illustrated in Figure 3.

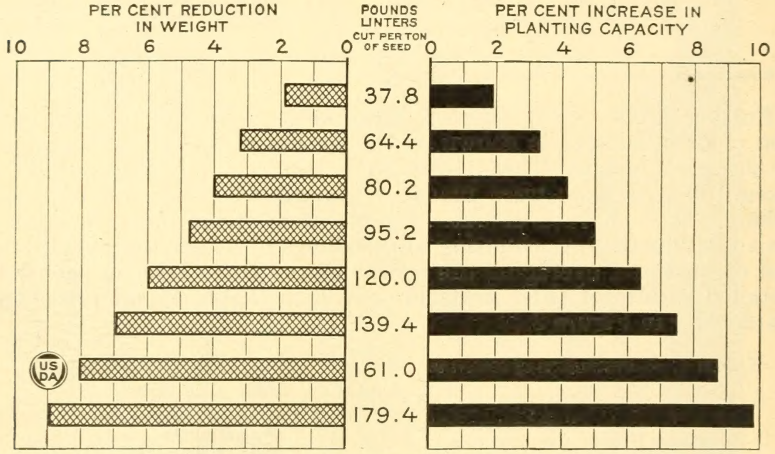


FIG. 3.—Delinting reduces the weight of a given number of cottonseed and increases the number of seeds and consequent planting capacity per unit of weight. Such reduction in weight or increase in planting capacity is in direct proportion to the quantity of linters removed per ton of seed.

TABLE 5.—*Reduction in weight of individual cottonseeds by delinting and increase in planting capacity per ton of delinted compared with ginned seed.*

Rate of delinting (linters per ton).	Reduction in weight of individual seeds.	Increase in number of seeds and in planting capacity per ton.	Rate of delinting (linters per ton).	Reduction in weight of individual seeds.	Increase in number of seeds and in planting capacity per ton.
Pounds.	*Per cent.*	*Per cent.*	*Pounds.*	*Per cent.*	*Per cent*
37. 8	1. 89	1. 92	120. 0	6. 00	6. 38
64. 4	3. 22	3. 33	139. 4	6. 97	7. 49
80. 2	4. 01	4. 18	161. 0	8. 05	8. 75
95. 2	4. 76	5. 00	179. 4	8. 97	9. 85

WEIGHT PER BUSHEL OF DELINTED SEED.

Removal of the linters from ginned cottonseed reduces the volume per unit of weight and increases the weight per measured bushel. This has resulted in some confusion to those accustomed to thinking of cottonseed in terms of bushels or the commonly accepted weight per bushel of ginned seed. The legal weight per bushel of ginned upland cottonseed varies from 28 pounds to 33⅓ pounds in the cotton-producing States. In most States, however, the legal weight is 30 or 32 pounds and a large percentage of the dealers who quote prices per bushel specify only 30 pounds. For this reason a weight of 30 pounds per bushel for ginned seed was chosen as a basis for comparing the weight per bushel of delinted seed.

The grain weight-per-bushel tester, described in United States Department of Agriculture Bulletin 472, was tried out for determining the weight per bushel of cottonseed but without satisfactory results. Ginned cottonseed will not flow through the funnel-shaped hopper used on the grain tester. The linters on the seeds also prevent them from settling in the quart kettle used so that they will test 30 pounds per bushel and interfere with stroking the excessive seeds from the kettle. Therefore a special device was constructed which would overcome these objections. (See fig. 4.) This device is a modification of the grain weight-per-bushel tester. The funnel-shaped hopper was replaced by a cylinder or tube the same diameter as the quart test kettle—4½ inches. It was 7½ inches high, with an opening 7 inches in diameter tapering to the size of the tube, being 10 inches high over all. When this tube is placed directly over the test kettle and the tube and kettle filled with seeds to the desired height, pressure may be applied so as to force more seeds into the kettle.

The tube is fixed in a frame pivoted on a vertical steel post and may be adjusted to any desired height above the kettle. A space of one-fourth inch between the kettle and tube was found to be most desirable. By means of a specially designed cut-off, consisting of a set of square steel fingers, sharpened to a fine point, curved slightly and set one-sixteenth inch apart in a semicircular frame with a radius of 2½ inches pivoted on the vertical steel post, which is drawn through the seeds between the kettle and the tube, the seeds in the kettle are more accurately separated from those in the tube. The cut-off also serves as a bottom for the tube and when in this position the tube and its contents may be swung to one side giving free access to the seeds in the kettle which are weighed to ascertain the weight per bushel.

In making the test weights, ginned cottonseeds were poured into the kettle from a dockage pan, one edge of which rested on the tube, until the kettle and tube were filled to a point 2½ inches from the top of the tube. Pressure was then applied to the seeds by placing lead weights in the tube. By means of the cut-off, the seeds in the tube were separated from those in the kettle. The contents of the kettle were then weighed to ascertain the weight per bushel. After repeating this experiment several times it was found that a pressure of 13½

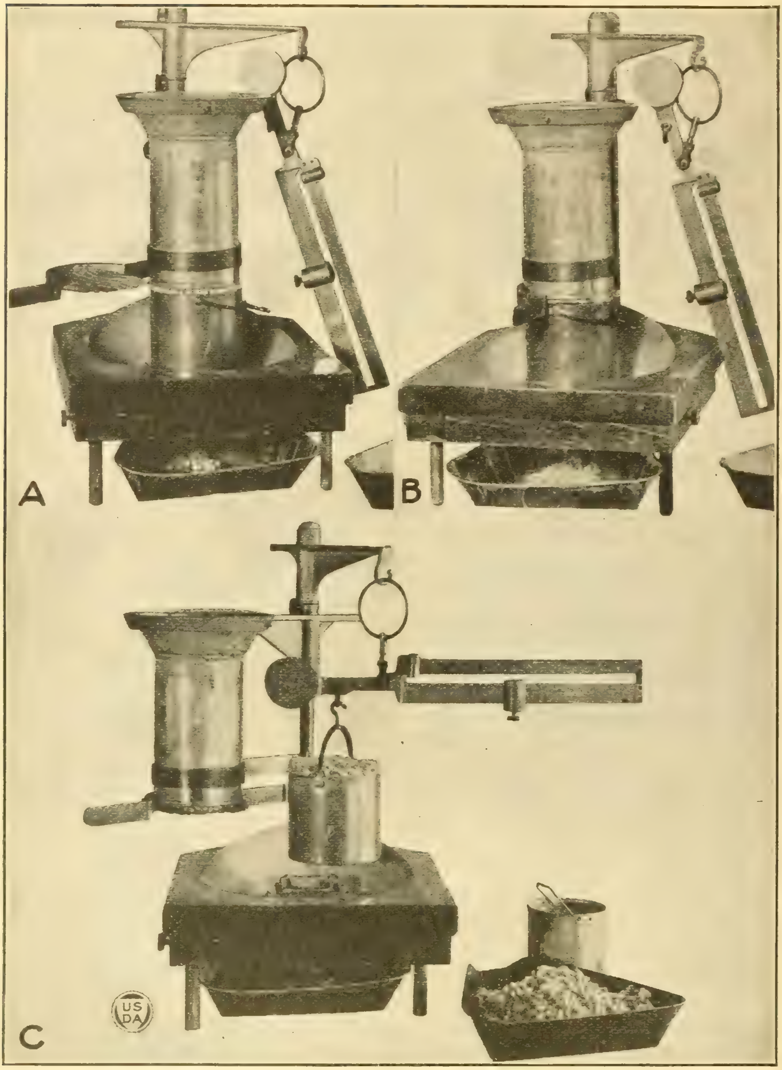


FIG. 4.—A specially designed device for testing the weight per bushel of cottonseed in order to determine the volume of delinted seed per unit of weight compared with that of ginned seed. *A*, Tube and kettle filled with seeds and the specially designed cut-off in position to be drawn through the seeds between the tube and the kettle. *B*, Cut-off drawn through the seeds, separating those in the tube from those in the kettle. *C*, Tube and its contents swung to left, cut-off serving as a bottom for the tube, and contents of kettle being weighed to determine the test weight per bushel, which is automatically registered on the scale beam.

pounds [3] was required to force enough ginned seeds into the kettle to test 30 pounds per bushel, which was the basic weight desired.

Test weights were then made with seeds delinted at varying rates, applying the same pressure in each case as was required for ginned seed to test 30 pounds. The weights per bushel as shown by these tests, together with the volume of 30 pounds in terms of a bushel, are given in Table 6. A comparison of the weight per bushel and volume per unit of weight of delinted seed with that of ginned seed also is shown graphically in Figure 5.

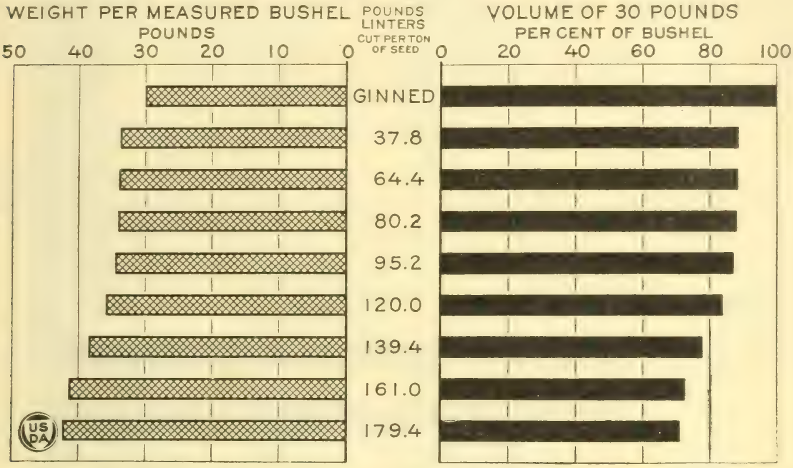


FIG. 5.—Delinting increases the weight per measured bushel and reduces the volume of a given weight of cottonseed.

TABLE 6.—*Weight per bushel and volume of 30 pounds of delinted cottonseed compared with ginned seed when 30 pounds ginned seed equals 1 bushel.*

Rate of delinting (linters per ton).	Weight per bushel.		Volume of 30 pounds.	
	Actual.	Per cent of ginned seed.	Per cent of bushel.	Decreased by delinting.
Pounds.	*Pounds.*	*Per cent.*	*Per cent.*	*Per cent.*
Ginned.	30.00	100.0	100.00	....
37.8	33.78	112.6	88.81	11.19
64.4	33.90	113.0	88.50	11.50
80.2	34.06	113.5	88.08	11.92
95.2	34.44	114.8	87.11	12.89
120.0	35.82	119.4	83.75	16.25
139.4	38.48	128.3	77.96	22.04
161.0	41.34	137.8	72.57	27.43
179.4	42.28	140.9	70.96	29.04

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[3] The pressure required varies with different varieties and may vary with different lots of the same variety. The pressure of 13½ pounds applies only to this test which was made to determine the comparative weight per bushel of ginned and delinted seed as a basis for computing the comparative volume and not to fix a standard pressure to be used in making test weights of cottonseed. Tests made with the Cleveland variety show a similar relationship between the weight per bushel of delinted and ginned seed of that variety and the indications are that when tests with any variety are made in accordance with the procedure outlined here the comparative results will be little different from those obtained with the Express variety although varying degrees of pressure may be required to force enough ginned seeds into the quart kettle to test 30 pounds per bushel.

These tests show that the weight per bushel increases perceptibly with the removal of about 40 pounds of linters per ton of seed. Further increase in weight is small until the rate of delinting exceeds 100 pounds per ton of seed. From this point on to the maximum safe rate of delinting the weight per bushel increases much more rapidly in proportion to the rate of delinting.

The volume per unit of weight is affected by delinting inversely as the weight per bushel and the volume decreases slightly less rapidly than the weight increases. In this test, for example, the weight per measured bushel, of the sample delinted at a rate of 161 pounds linters per ton of seed, was 41.34 pounds, or 37.8 per cent greater than the ginned sample, while the volume of 30 pounds was about 72.5 per cent of a bushel, less than 3 pecks, or 27.5 per cent less than the volume of 30 pounds of ginned seed.

DELINTING A PREREQUISITE FOR RECLEANING.

Recleaning cottonseed is the logical outcome of the successful removal of the surplus lint. The operation is justified by the greater agricultural value of the recleaned seed. That cottonseed breeders, growers, and dealers appreciate this fact is evidenced by the increased number who are installing recleaning machines which appear to be designed for effective work.

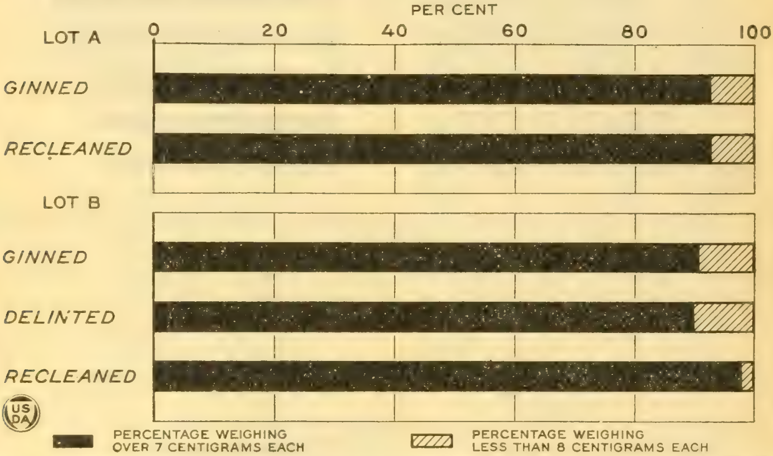
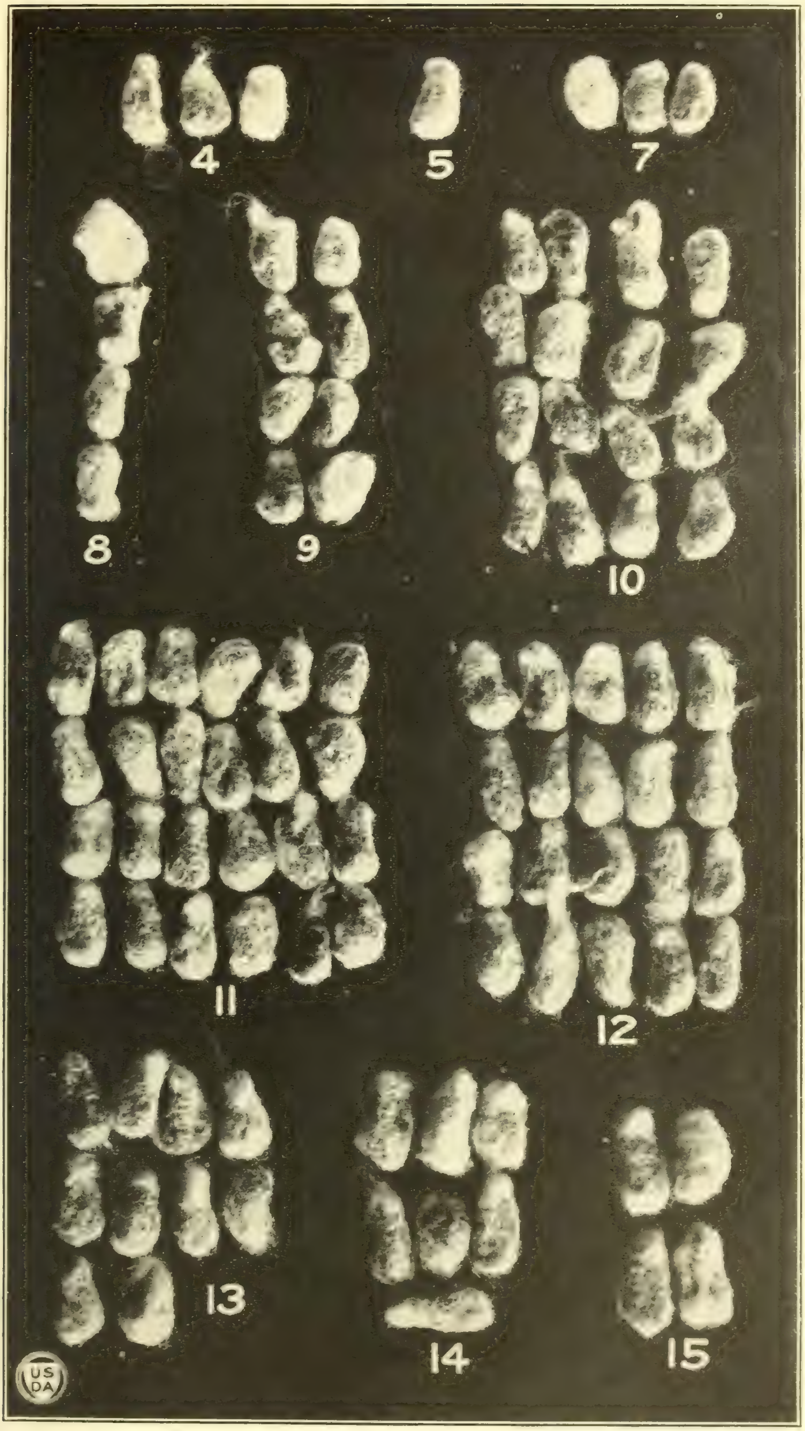


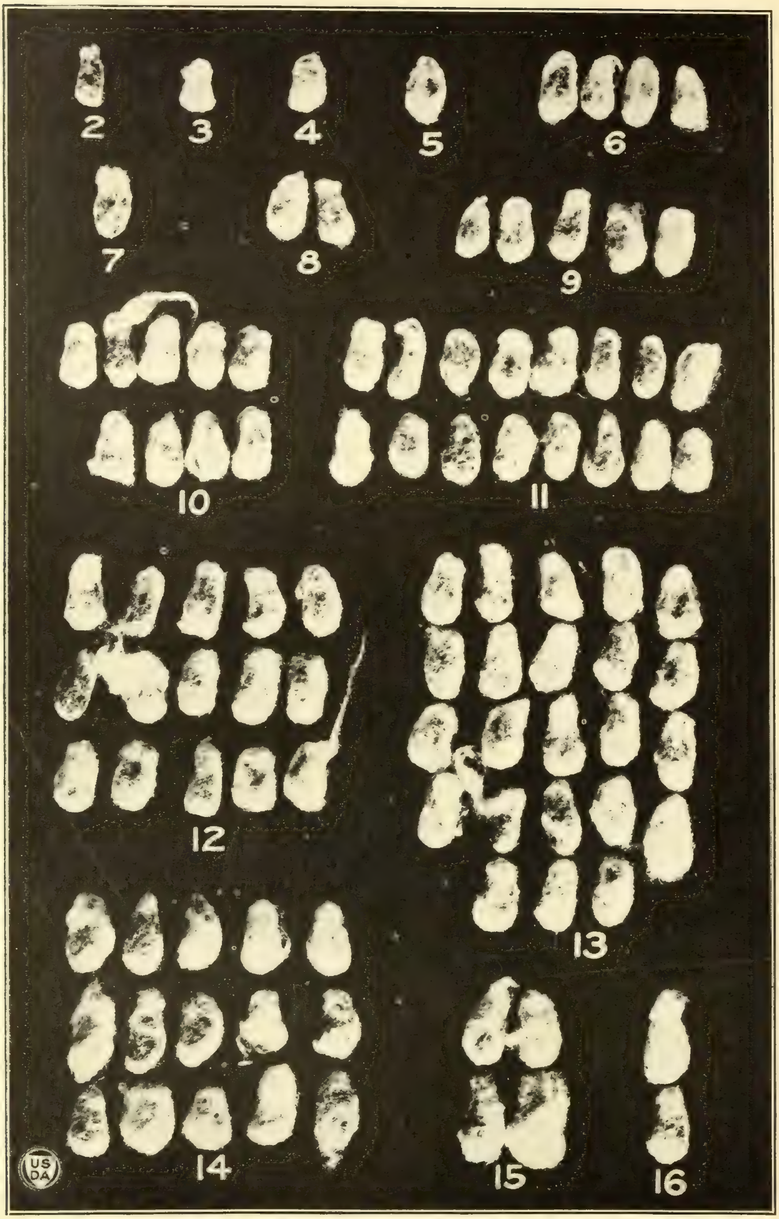
FIG. 6.—Ginned cottonseeds that were recleaned (Lot A) showed little or no improvement with respect to the percentage of lightweight seed contained, whereas ginned seeds that were first delinted (Lot B) and then recleaned contained only 20 per cent as many lightweight inferior seeds as originally.

The efficiency of the machines, however, is dependent largely upon the condition of the seed to be recleaned. Linters on the most carefully ginned seeds interfere with the flow of seeds over either oscillating or revolving screens and prevent an accurate separation of the lightweight and heavyweight seeds when subjected to an air blast. Many heavyweight seeds that are covered with surplus linters or partially covered with long lint are screened or blown out, while small or lightweight inferior seeds, which may have been ginned more closely, pass through with the recleaned seeds.



RECLEANED GINNED COTTONSEED FROM THE SAME LOT ILLUSTRATED IN PLATE II.

Figures indicate the weights in centigrams of the individual seeds in each group. Note that seven weigh less than 8 centigrams each, which indicates that the number of lightweight seeds present was not reduced by recleaning ginned seed. Slightly reduced in size.



GINNED COTTONSEED FROM ANOTHER LOT WHICH WAS LATER DELINTED AND RECLEANED WITH THE RESULTS SHOWN IN PLATES V AND VI.

Figures indicate the weights in centigrams of the individual seeds in each group. Note that nine weigh less than 8 centigrams each. Slightly reduced in size.

The presence of lightweight seeds is not easily discernible by a casual examination, but detailed analyses of a number of recleaned, ginned samples show conclusively the necessity for delinting the seeds before they can be recleaned effectively. Samples of each of ginned and recleaned seed were submitted by a number of dealers who reclean cottonseed without delinting. Weights of each of 100 seeds in each sample were made with the results as shown in Table 7.

TABLE 7.—*Individual weights of ginned cottonseed before and after recleaning.*

Dealer.	Condition of seeds.	Percentage of seeds weighing in centigrams—														Percentage weighing less than 8 centigrams.
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	
A	Ginned	0	2	1	1	2	1	4	7	13	21	18	18	8	4	6
	Recleaned	1	1	0	1	1	3	3	13	15	19	20	13	9	1	4
B	Ginned	1	0	0	2	1	0	2	5	16	16	17	17	12	11	4
	Recleaned	1	1	0	2	1	0	2	4	10	12	16	24	15	12	5
C	Ginned	1	2	2	1	1	3	5	12	21	26	16	7	3	0	7
	Recleaned	0	1	1	2	2	3	8	18	21	22	16	5	1	0	6
D	Ginned	2	1	2	2	1	8	16	23	16	13	10	4	2	0	8
	Recleaned	2	1	0	3	3	5	12	24	18	15	12	4	1	0	9
E	Ginned	2	1	1	3	2	4	8	21	22	23	8	5	0	0	9
	Recleaned	0	2	0	2	2	7	8	25	17	23	10	4	0	0	6
F	Ginned	2	1	2	0	2	4	9	12	20	20	18	7	2	1	7
	Recleaned	0	3	1	0	3	4	7	16	24	21	10	7	4	0	7
G	Ginned	1	1	1	2	3	2	10	30	26	16	8	0	0	0	8
	Recleaned	0	1	0	3	5	5	12	20	22	24	7	1	0	0	9
H	Ginned	3	2	1	1	0	5	14	20	22	16	10	5	1	0	7
	Recleaned	1	0	2	1	4	4	13	14	19	22	11	7	1	0	8
I	Ginned	3	2	2	0	1	4	9	12	14	18	10	12	10	3	8
	Recleaned	0	4	3	0	2	4	1	8	9	12	20	15	14	8	9
J	Ginned	2	2	1	3	0	4	16	15	18	20	9	7	3	0	8
	Recleaned	3	0	2	4	1	7	11	18	22	15	12	4	1	0	10

The average percentage of the seeds in the samples submitted by the 10 dealers in the foregoing table, weighing less than 8 centigrams each, is practically the same for the ginned or unrecleaned as for the recleaned seed—7.2 and 7.3 per cent, respectively. It may be seen readily from the individual tests that there is little or no improvement in the recleaned seeds over the original ginned sample in each lot. Much of the inert matter—trash, burs, dirt, and loose particles of lint—is removed, but the percentage of lightweight seeds remaining is practically the same. (See Pls. II and III, and fig. 6, *a*.)

Delinting partially recleans the seed, removing the surplus lint and some of the inert matter, but it does not eliminate the lightweight, immature seeds and much of the trash. Analyses of delinted samples which had not been recleaned showed that the percentage of lightweight seeds present was the same as before delinting. However, delinting does facilitate recleaning. Samples of recleaned delinted seed analyzed contained only 20 to 25 per cent as many lightweight seeds as the delinted or the ginned samples from the same lot. Detailed results of these analyses are given in Table 8 and illustrated in Plates IV, V, and VI, and graphically in Figure 6, *b*. There is a slightly larger percentage of lightweight seeds in the delinted lot because the removal of the linters reduces the weight of the individual seeds and necessarily throws some of those weighing 8 centigrams each before being delinted into the 7-centigram or lightweight class after being delinted.

TABLE 8.—*Comparison of the individual weights of ginned, delinted, and recleaned delinted cottonseed.*

Condition of seed.	Percentage of seeds weighing in centigrams—															Percentage weighing less than 8 centigrams.
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Ginned	1	1	1	1	4	1	2	5	9	16	15	23	15	4	2	9
Delinted	1	1	2	2	1	3	4	8	15	21	18	17	6	1	0	10
Recleaned delinted	0	0	0	0	0	2	2	7	12	28	25	16	6	2	0	2

LOSS OF GOOD SEEDS IN RECLEANING.

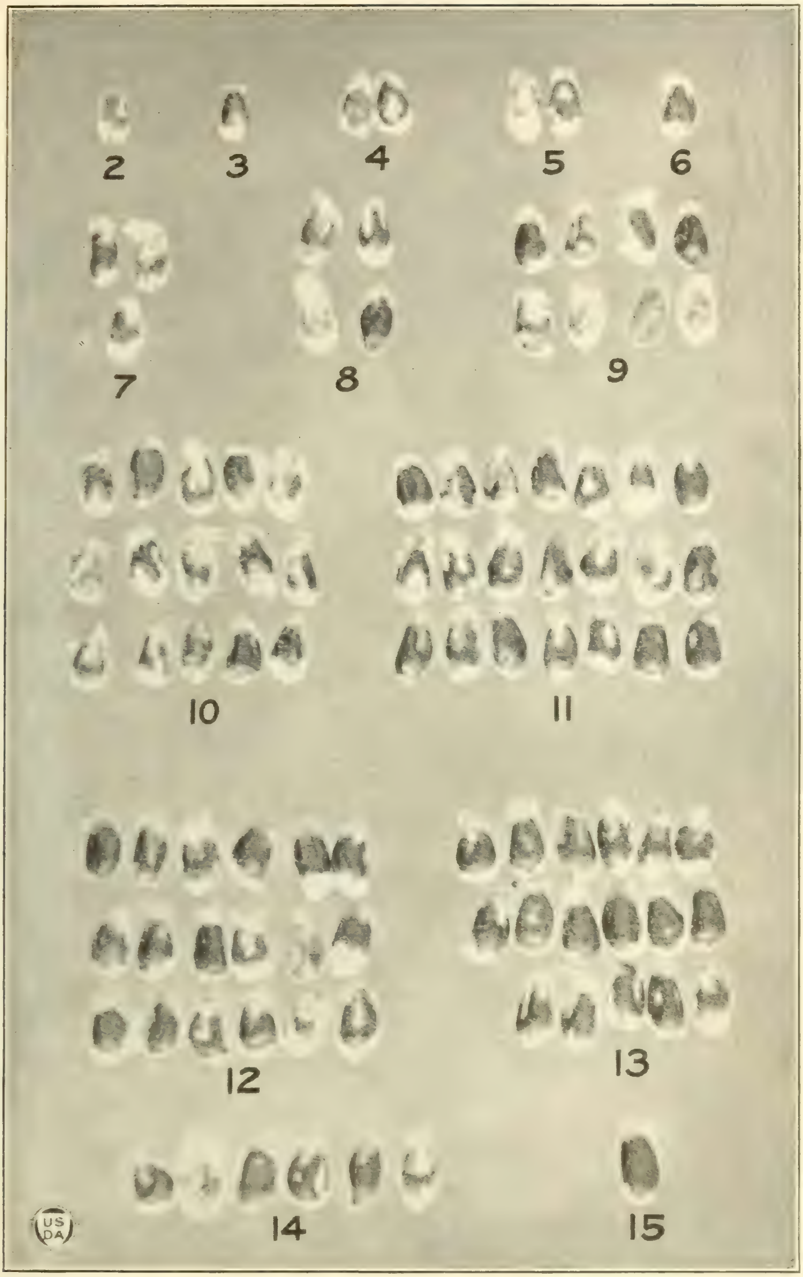
An important factor to consider in connection with recleaning cottonseed is the class of dockage removed or more specifically the percentage of good seeds lost in the operation. Recleaning machines of both the oscillating and rotary screen types (see fig. 7, A and B) make four separations as follows: (1) Trash and loose lint going over top screen; (2) dirt, very small and broken seeds, and small trash through lower screen; (3) Lightweight seeds blown out by fan; and (4) recleaned and graded seeds.

To ascertain what effect delinting might have on this phase of recleaning, samples of lightweight seed or dockage were obtained from several dealers who operate recleaners. Detailed analysis of a representative sample of dockage from each of ginned and delinted seed is shown in Table 9 and illustrated in Plates VII and VIII.

TABLE 9.—*Individual weights of seeds cleaned out of ginned and delinted cottonseed.*

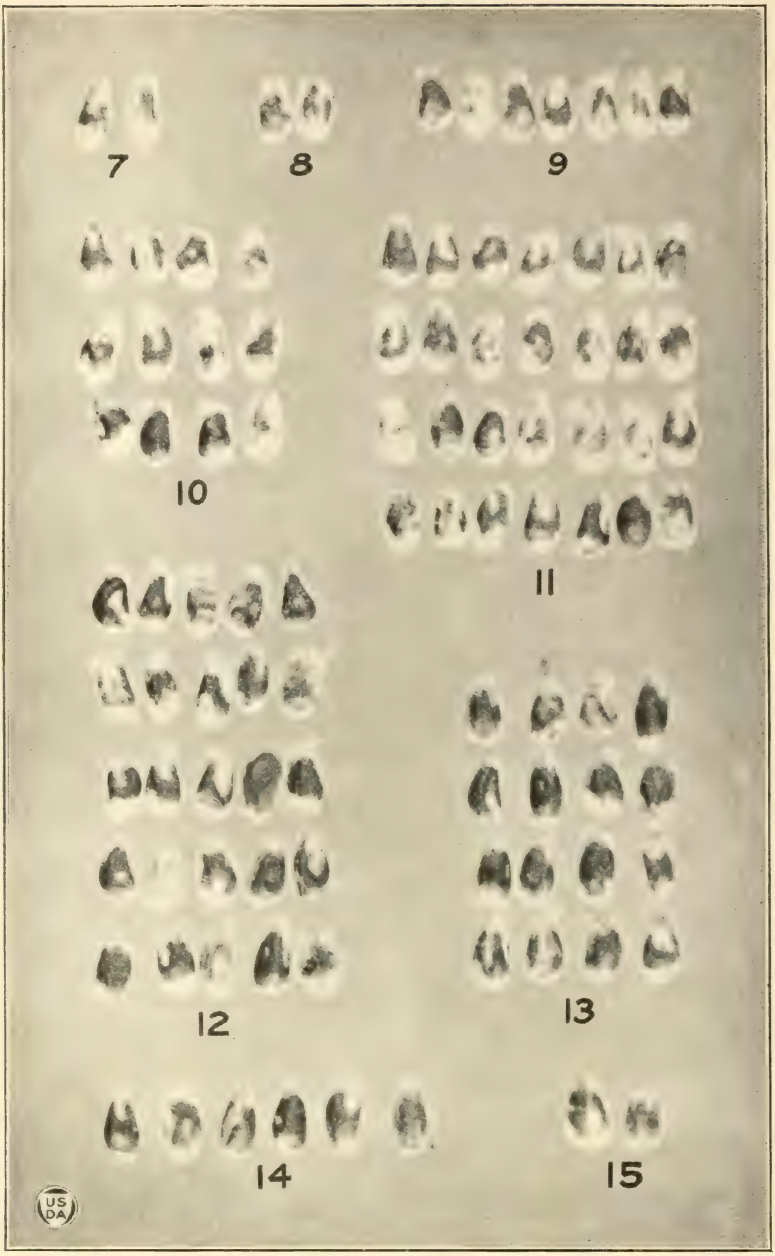
Condition of seed recleaned.	Percentage of seeds weighing in centigrams—														Percentage weighing—	
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Over 7 centigrams.	Over 9 centigrams.
Ginned	5	9	9	5	2	5	6	7	12	12	14	9	4	1	65	52
Delinted	4	19	24	18	12	8	6	6	2	1	....	....	....	....	15	3

In the ginned sample, 65 per cent of the seeds cleaned out weighed over 7 centigrams each, tested 87 per cent germination in the laboratory and otherwise were of as good quality for planting purposes as the original ginned lot. Many of these seeds contained an excessive quantity of long lint. (See Pl. VII.) By more careful ginning, much of this lint would have been removed and the percentage of good seeds cleaned out would have been reduced somewhat. Furthermore, delinting would have made it possible to reclean and grade this lot of seed with a minimum loss of good seeds.



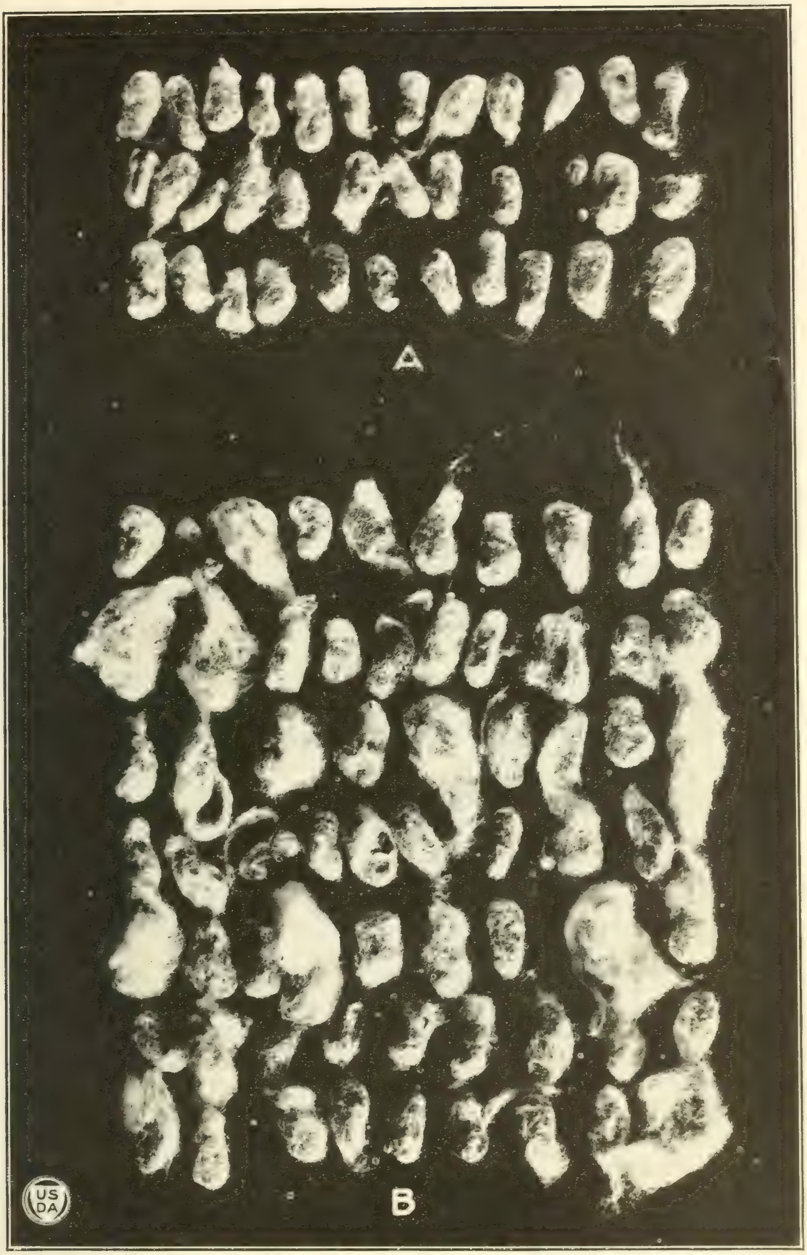
DELINTED COTTONSEED (NOT RECLEANED).

Figures indicate the weights in centigrams of the individual seeds in each group. Note that 10 weigh less than 8 centigrams each compared with 9 seeds of such weight in the same lot before delinting as shown in Plate IV. Slightly reduced in size.



RECLEANED COTTONSEED, PREVIOUSLY DELINTED, AS IN PLATE V.

Figures indicate the weights in centigrams of the individual seeds in each group. Note that only two weigh less than 8 centigrams each and that these weigh 7 centigrams each. Compare these results with those in Plate III. Slightly reduced in size.



DOCKAGE FROM RECLEANING GINNED COTTONSEED ILLUSTRATED IN PLATE II, RESULTING IN THE SO-CALLED RECLEANED SEED ILLUSTRATED IN PLATE III.

Only 35 per cent of the seeds cleaned out weigh less than 8 centigrams each as shown in (A) while 65 per cent weigh over 7 centigrams each as in (B), indicating a heavy loss of good seeds. Compare with Plate VIII.

DOCKAGE FROM RECLEANING DELINTED COTTONSEED ILLUSTRATED IN PLATE V, RESULTING IN THE RECLEANED SEED ILLUSTRATED IN PLATE VI.

Eighty-five per cent of the seeds cleaned out are lightweight and inferior as shown in (A), weighing less than 8 centigrams each, while only 15 per cent weigh over 7 centigrams each as in (B), showing a relatively small loss of good seed.

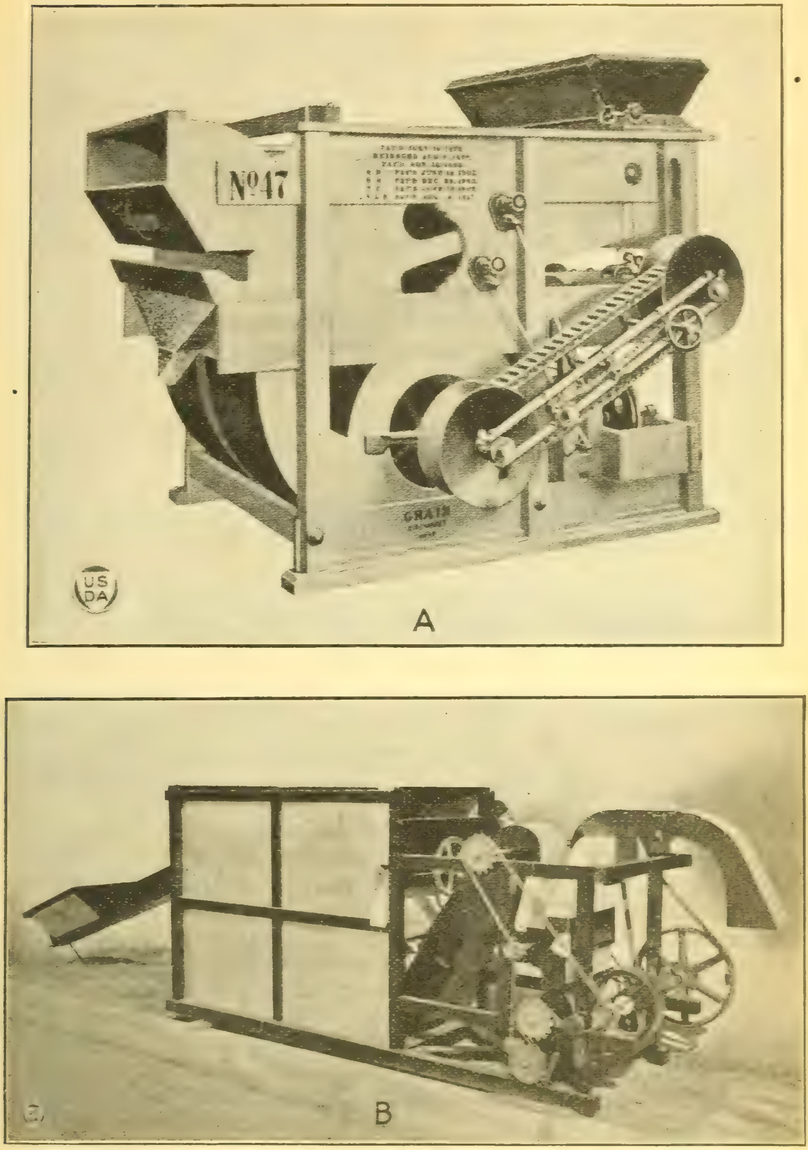


FIG. 7.—Seed-cleaning machines adapted for use in recleaning cottonseed. *A*, Oscillating screen type; *B*, double rotary screen type. Both of these machines are equipped with a fan and are manufactured in different sizes. Other machines of special designs are being used with varying degrees of success.

Because of this long lint, an unusually large percentage of the dockage was carried over the top screen. For this reason also this class of dockage contained over 90 per cent of heavy weight seeds. Tests show that there is little if any loss of good seeds from this source when recleaning seed that has been delinted closely. Of the ginned seeds going through the bottom screen and being blown out by the fan, over 50 per cent weighed more than 7 centigrams each, ranging from 8 to 15 centigrams. This loss is much greater than necessary. In recleaning delinted seeds the percentage of heavy weight seeds contained in screenings from the bottom screen was only 25 per cent and from the fan less than 10 per cent. On the average only 15 per cent of the seeds cleaned out of the delinted lots weighed over 7 centigrams each and only 3 per cent weighed over 9 centigrams each. (See Pl. VIII.)

The weights of the individual seeds cleaned out of ginned and delinted seeds are shown in detail in Table 9. With 65 per cent of the seeds in screenings from ginned seed weighing over 7 centigrams each compared with only 15 per cent in screenings from delinted seed, the preventable loss in recleaning by first delinting the seeds is represented by 50 per cent of the number of seeds cleaned out. (See fig. 8.) Based on the total weight of the seeds cleaned out, the preventable loss in recleaning the ginned lot is still greater. The total weight of 100 ginned seeds cleaned out is 904 centigrams, but the total weight of the 65 heavyweight seeds in this 100 is 759 centigrams or 84 per cent of the total weight. On the other hand the total weight of 100 delinted seeds cleaned out is only 512 centigrams and of the 15 heavyweight seeds in this 100, 133 centigrams or only 26 per cent of the total. Hence, in this case delinting offers the possibility of saving 84 per cent less 26 per cent, or 58 per cent, by weight of the seeds cleaned out by the recleaning machines.

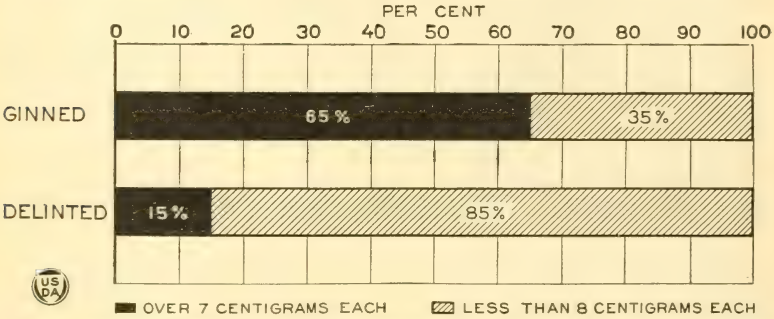


FIG. 8.—An unnecessarily large percentage of the seeds cleaned out of ginned cottonseed is heavy-weight and of good quality. Delinting the seeds before recleaning them permits a more accurate separation of the light-weight and heavy-weight seeds and reduces the loss of good seeds to the minimum.

DOCKAGE IN DELINTING AND RECLEANING COTTONSEED.

Total dockage in recleaning cottonseed necessarily varies with the condition of the seed to be recleaned and the quantity of inert matter and lightweight seeds present. There is considerably less inert matter in delinted than in ginned seeds but the percentage of immature, lightweight, or otherwise inferior seeds is practically the same.

To remove these inferior seeds and the inert matter without the loss of good seeds is of far greater importance than anxiety regarding apparently excessive dockage. By preventing the loss of heavy-weight seeds, however, the dockage is reduced to the minimum consistent with efficiency in recleaning.

If cottonseed is well matured and carefully ginned and delinted, the total dockage in recleaning should not exceed 5 per cent. In recleaning the delinted seeds from which the lightweight seeds shown in Plate VIII were taken, the total dockage averaged only 4 per cent; while in recleaning the ginned seed (see Pls. II and III) the total dockage, of which the so-called lightweight seeds in Plate VII were taken, was 20 per cent. Granting that three-fourths of the total dockage in recleaning the ginned seeds was composed of seeds as shown in Plate VII, a saving of 58 per cent of that portion would mean a net reduction of 43.5 per cent in the total dockage. In other words the total percentage of dockage including inert matter would have been reduced from 20 per cent to 11.3 per cent.

In some instances which have come to the writer's attention the dockage in recleaning ginned seed was only 2 to 3.5 per cent. A comparison of the ginned and recleaned seeds in each case based on the weights of the individual seeds showed little or no reduction in the number of lightweight seeds present and slight improvement as to the percentage of inert matter contained. This is also true of other ginned samples analyzed where the dockage in recleaning was from 12 to 20 per cent which, in connection with the data given in the foregoing paragraphs, indicates that not only is much good seed lost in attempting to reclean ginned seed but the results are not satisfactory from the standpoint of the lightweight seeds and inert matter removed.

The dockage in delinting and recleaning cottonseed is composed of linters, culled seed, and inert matter. Based on a number of experiments and extensive observations and investigations of commercial delinting and recleaning operations, it is found that where the seeds are delinted closely and recleaned efficiently the average products per ton are approximately as follows:

	Pounds.
Linters	140
Culled seed	80
Inert matter	80
Total dockage	300
Recleaned and graded seed	1,700
Total	2,000

As shown, the total dockage or shrinkage is 300 pounds per ton or 15 per cent. From a commercial point of view this shrinkage is of importance chiefly in so far as it affects the monetary value of a given lot of seeds. On this basis the net loss is not so great, being reduced by the market value of the linters and of the culled seed. When 140 pounds of linters per ton is cut the linters are known commercially as No. 3 or mill-run which is a relatively low grade having a market value during normal times equal to 10 to 15 per cent of the price of middling short staple cotton. The culled seeds may be sold to cottonseed oil mills at about 75 per cent of the current market price of cottonseed for oil manufacture.

COST OF DELINTING AND RECLEANING.

The cost of delinting and the factors which must be taken into consideration in determining the cost were discussed in United States Department of Agriculture Bulletin 1056. In the example given in that discussion it was shown that, in a 2-unit delinting plant, the factors of labor, power, depreciation in the machinery, and interest on the investment amounted to only $3.80 for delinting 1 ton of ginned seed. The cost of recleaning is even smaller because less labor is required and the investment is only one-tenth to one-fifth as large. A recleaning machine of sufficient capacity to take care of the output of a 2-unit delinting plant and to insure efficient results may be purchased and installed, with conveyers necessary for economy of operation, for $250 to $650. (See fig. 7). When so installed in a 2-unit delinting plant the total gross cost of both delinting and recleaning should not exceed $5 per ton of ginned seed. This figure includes the cost of labor and power, interest on investment, and depreciation, but it does not cover the loss from shrinkage and no allowance is made for the value of the linters and culled seed.

The cost of recleaned seed per ton as a basis for determining the selling price may be computed by adding the cost of delinting and recleaning to the original cost of the ginned seed, deducting the market value of the linters and culled seed, multiplying the remainder by 2,000, and dividing the product by the number of pounds of recleaned seed obtained from a ton. For example:

Cost of ginned seed per ton	$40.00
Cost of delinting and recleaning	5.00
Total	45.00
Less the value of dockage:	
140 pounds linters at $0.03 per pound	4.20
80 pounds culled seed at $30 per ton	1.20
80 pounds inert matter (no value).	
Total	5.40
Net cost of 1,700 pounds of delinted and recleaned seed resulting from 1 ton of ginned seed	39.60
Net cost per ton of delinted and recleaned seed $\left(\frac{39.60 \times 2,000}{1,700}\right)$	46.59

In this example, if ginned cottonseed cost, or is valued at, $40 per ton, delinted and recleaned seed from the same lot would cost $46.59 per ton and an increase of $6.59 per ton in the selling price over that originally charged for ginned seed would be necessary if the same margin of profit is to be obtained. This is equivalent to 33 cents per 100 pounds or about 10 cents per bushel of 30 pounds. Any reduction in the quantity of inert matter removed or increase in the price of linters lowers the net cost of delinting and recleaning proportionately. All of the factors affecting the cost of these operations may vary from year to year or under different conditions and this example, representing the cost under average conditions, is given for the purpose of illustrating how the cost may be determined. In any case, the cost is offset further by the increased number of good seeds per ton and the consequent greater planting capacity.

The reduced cost of hauling and freight is an important factor in the comparative cost of recleaned delinted cottonseed to the farmer. When 1,700 pounds of recleaned delinted seed contains the same number of good seeds as 2,000 pounds, or a ton, of ginned seed the difference in freight charges at a shipping distance represented by a freight rate of $1 per 100 pounds would amount to a saving of $3. In other words, on the basis of the foregoing example of values and freight rates, 1 ton of ginned seed would cost $60 delivered, and 1,700 pounds of recleaned delinted seed, having the same planting capacity, would cost only $56.60.

It was shown in Table 5, page 6, that when cottonseed is delinted at a moderate rate the number of all seeds per ton of delinted seed is 5 per cent greater and when delinted closely 8 or 9 per cent greater than in a ton of ginned seed. Not over 1 per cent of the good seeds are lost in recleaning after delinting, and practically the same number of good seeds remain from a ton of ginned seed after it is delinted and recleaned as originally existed. If the weight of the recleaned, delinted seed obtained from a ton of ginned seed is only 1,700 pounds, as in the above example, then 1 ton of the finished product would contain approximately 17.5 per cent more good seeds than 1 ton of ginned seed. The net increase in the cost of delinted and recleaned seed per ton, however, is only 16.5 per cent in the example. In other words the cost of delinting and recleaning cottonseed, including the shrinkage, is more than offset by the increased number of good seeds per ton.

The number of good seeds per unit of weight is the correct basis of comparative values from the farmer's point of view because this factor directly affects the planting capacity. An increase of 15 to 20 per cent in the price paid for recleaned delinted seed over that paid for ginned seed would not mean ordinarily an increased cost of the quantity required per acre. The recleaned delinted seeds have a greater planting capacity not only as a result of the increased number of seeds per unit of weight but because they may be distributed more uniformly and the quantity or number of seeds sown per acre further reduced without endangering the possibilities of obtaining a stand of plants.

AGRICULTURAL POSSIBILITIES OF DELINTED AND RECLEANED COTTONSEED.

The ultimate value of any process of improving the physical condition of seed is measured by the agricultural advantages accruing to the farmer who plants such seeds. Commercially, any operation of this kind must pay its own way and to do this the results must be reflected in either increased or more economical yields. Results obtained by some of the largest cotton growers from planting delinted and recleaned cottonseed over a period of from three to eight years indicate clearly that the practice is worthy of universal adoption.

The following paragraphs on the agricultural advantages of delinting are taken, with slight modification, from United States Department of Agriculture Bulletin 1056, Marketing Cottonseed for Planting Purposes:

> Delinting promotes a uniform stand of plants by enabling the seeds to germinate more nearly simultaneously and with the aid of less moisture. There is a wide variation in the quantity of lint left on individual ginned seeds and when planted the seeds with the shortest lint on them come into closer contact with the soil moisture and germinate more quickly than those containing excessive lint.
>
> Closely delinted seeds contain a very small, uniform quantity of short lint or fuzz, germinate at practically the same time, and produce a more nearly perfect stand of plants at least two or three days earlier. This is of value in growing cotton under conditions of boll weevil infestation because every day gained in getting the plants above the ground increases the prospects of obtaining a profitable yield.

> Delinting assists materially in the emergence of cotton seedlings. Cottonseeds, in germinating, are forced up through the soil on the cotyledons of the young seedlings and a closely delinted seed offers less resistance than ginned seed. Also the united action of the young seedlings, resulting from the simultaneous germination of the delinted seeds, enables them to break through soil that has been compacted by rains with comparatively little difficulty and helps to insure a stand of plants under adverse conditions.
>
> Delinting effects an economy in the use of cottonseed, as planting machines will distribute a smaller quantity per acre more evenly. It will eliminate the necessity of a force feed in planting machines and facilitate the single-seed distribution and the planting of cottonseed in hills. The thin uniform stand of plants made possible by the use of delinted and recleaned seed also may help to simplify the culture of cotton by what is known as the single-stalk method which, repeated experiments show, produces the highest yields and earliest maturity.

In a few instances which have recently come to the writer's attention, delinted and recleaned seed are being planted with corn, bean, or peanut planters now on the market in the South, spacing the seeds the desired distance and effecting a saving of 25 to 50 per cent of the seeds required per acre. Furthermore, the proper spacing of the seeds in the drill makes it easily possible to eliminate the expensive thinning or "chopping" operation in the cultivation of the crop. Thus the use of delinted and recleaned cottonseed tends to lower the cost of production.

Any practice resulting in an increased yield with no additional cost also lowers the net cost of production per pound. In experiments conducted by the Bureau of Plant Industry in 1907,[4] recleaned or graded seed produced from 8.25 to 10.9 per cent more seed cotton per acre than seed not recleaned or graded. These seeds were rolled in some finely pulverized material sprinkled with water to paste down the lint or fuzz so that they would separate readily. The addition of water and foreign material introduces a possibility of error in separating the lightweight and heavyweight seeds which is not encountered when recleaning seeds that have been delinted closely. With the added advantages accruing from planting delinted seed there is no apparent reason why such seed when efficiently recleaned should not give even greater results than those in the experiment referred to.

Thus it appears that delinted and recleaned cottonseed may be made available to the farmer at no additional cost for the quantity required per acre and that the use of this seed adds to the net returns from the crop both by reducing the cost of production and by increasing the yield per acre. However, satisfactory results may be expected only when the seeds are delinted closely and then recleaned efficiently. Delinting, although a valuable factor in improving cottonseed for planting purposes, is not sufficient in itself, and recleaning can not be done economically nor efficiently unless the seeds are first delinted. The two processes are interdependent and when properly employed in conjunction with each other they offer marked possibilities for the advancement of the cotton-growing industry.

SUMMARY OF CONCLUSIONS.

Cottonseed may be delinted very closely with not over 1 per cent saw-cut injury. From 100 to 150 pounds of linters per ton of seed may be removed with safety. When delinted at the high rate very little linters or fuzz is left on the seeds and greater benefit is derived from the operation both as to duration required for germination and as to efficiency in recleaning.

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[4] Webber, Herbert J., and Boykin, E. B.: The Advantage of Planting Heavy Cotton Seed, U. S. Dept. of Agr., Farmers' Bulletin 285. 1907.

Delinting greatly accelerates the germination of cottonseeds. Under ideal conditions of moisture and temperature a full germination may be obtained with delinted seeds in two days less time than with ginned seeds, while under conditions of a deficiency of moisture the difference in duration in favor of the delinted seed is much greater.

Delinting reduces the weight of the individual seeds, thus increasing the number of seeds and consequent planting capacity of delinted seeds per unit of weight. For example, 161 pounds of linters removed per ton of seed reduces the weight of the individual seeds 8.05 per cent and a ton of such delinted seed would contain 8.75 per cent more seeds and have a correspondingly greater planting capacity.

Delinting reduces the volume of cottonseed per unit of weight and increases the weight per measured bushel. The volume of 30 pounds of seed delinted at a rate of 161 pounds of linters per ton was found to be 72.5 per cent, or less than three-fourths, of a bushel and a measured bushel of such seed weighed over 41 pounds or 37.8 per cent more than the corresponding ginned sample.

Delinting does not reclean cottonseed but it is a necessary prerequisite for recleaning and grading cottonseed efficiently and economically. The linters on ginned seeds interfere with the operation of recleaning machines and prevent an accurate separation of the lightweight and the heavyweight seeds when subjected to an air blast.

Recleaned ginned seeds on the average show little or no reduction in the percentage of lightweight seeds contained and slight improvement as to the inert matter removed, while recleaned delinted seeds are practically free of lightweight seeds and inert matter.

The loss of good seeds in recleaning ginned seed is unnecessarily heavy, over 75 per cent of the screenings sometimes being made up of heavyweight seeds, while such loss in recleaning delinted seeds may be reduced to a negligible quantity.

The total dockage or shrinkage in delinting and recleaning cottonseed varies with the condition of the seed as it comes from the gin. Any variation in the quantity of each class of dockage removed and in the price of linters and culled seed affects the net cost of the combined operations.

The cost of delinted and recleaned seed per ton as a basis for determining the selling price may be computed by adding the cost of delinting and recleaning to the original cost or value per ton of the ginned seed, deducting the market value of the linters and culled seed removed, multiplying the remainder by 2,000 and dividing the product by the number of pounds of recleaned seed obtained from a ton.

The net increase in the cost of delinted and recleaned cottonseed is offset by the increased number of seeds and consequent greater planting capacity per ton, and the combined operations—delinting and recleaning—offer the greatest possibilities for improving cottonseed for planting purposes by mechanical means without increasing the cost to the farmer for the quantity required per acre.

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October 1, 1923.

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